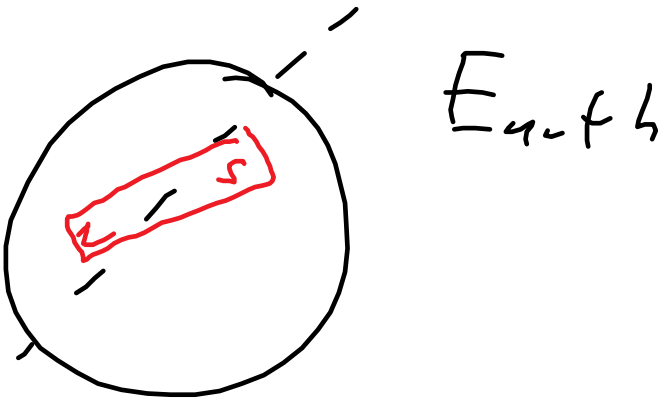
Magnetism

What is magnetism? What do you think of?

Magnets - they attract some metals (eg iron is attracted, copper is not)

Magnets attract other magnets but can also repel - They have poles - North and South poles.
like poles repel opposites attract.
The north pole of a magnet is attracted to the Earth's magnetic pole at its geographic north pole (a magnetic south pole)

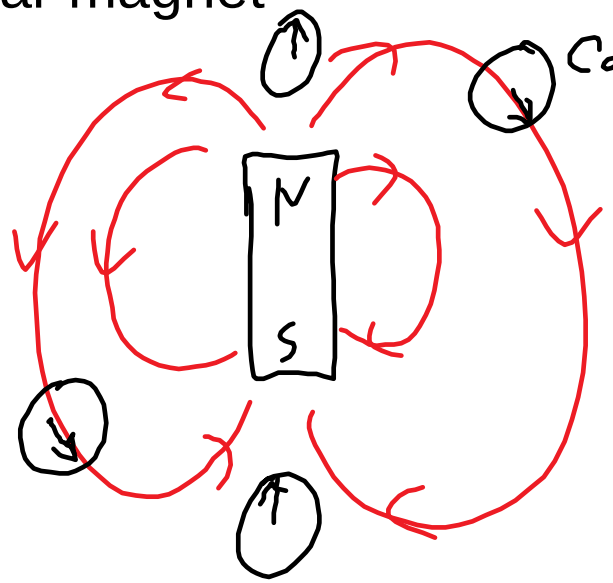


Earth acts like a giant bar magnet, compasses are magnets that align with the magnetic field.

Define the direction of a magnetic field as the direction the north end of a compass will point at that point.

Magnetic field, B around

a) a bar magnet



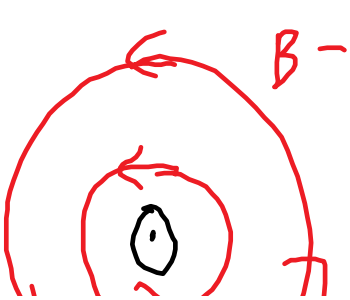
arrow points north
– or –
along the field line

b) horseshoe magnet

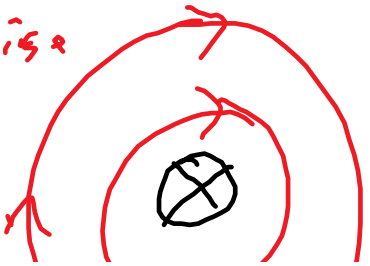
field lines go from North to South

c) two wires, one with current going into the page (symbol circle with anx) one with current going out of the page (circle with a dot). Think of an arrow going towards you for a dot, and the feathers of the arrow as the x.

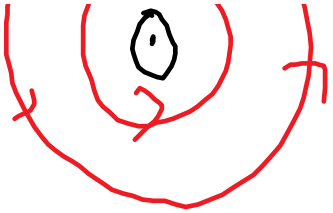
Big idea, electric current creates magnetic fields.



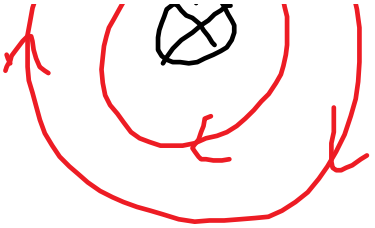
B – counter clockwise



B – Clockwise



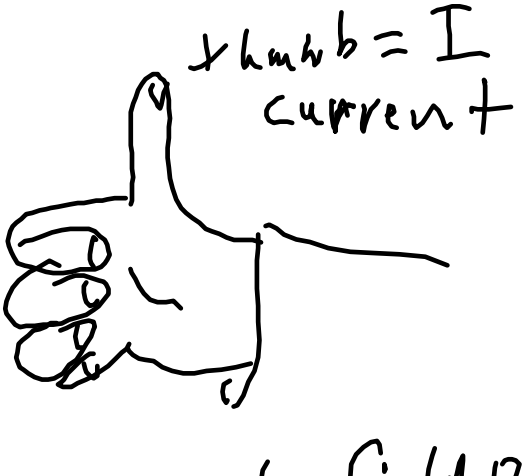
I out of page



I into the page

Right Hand Rule

First of three



Fingers = Magnetic field, B

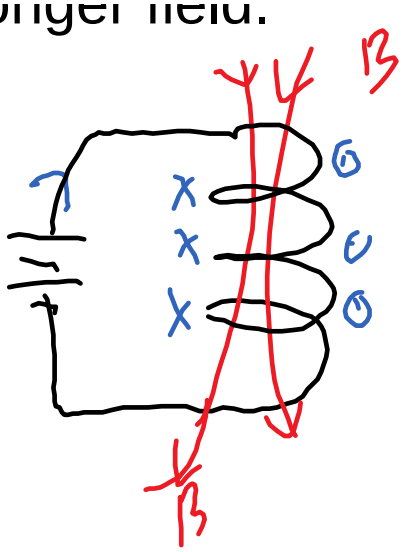
equation $B = \frac{\mu_0 I}{2\pi r}$

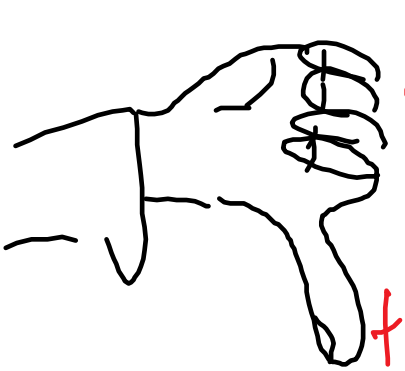
B is the magnetic field strength, in Teslas, T
T=N/Am
I is the current in the wire, in Ampères, A
r is the perpendicular distance to the wire, in m
μ_o is the permeability of free space, a fundamental constant of nature
$\mu_o = 4\pi \times 10^{-7}$ Tm/A

d) solenoid - a coil of wire. If one wire produces a magnetic field, a bunch of wires produces a stronger field.

B

stronger field.





Second right hand rule

$$B = \mu_0 \frac{N}{L} I = \mu_0 n I$$

N is the number of loops

L is the length of the solenoid in m

$$n = \frac{N}{L}$$

Magnetic Force, F_B

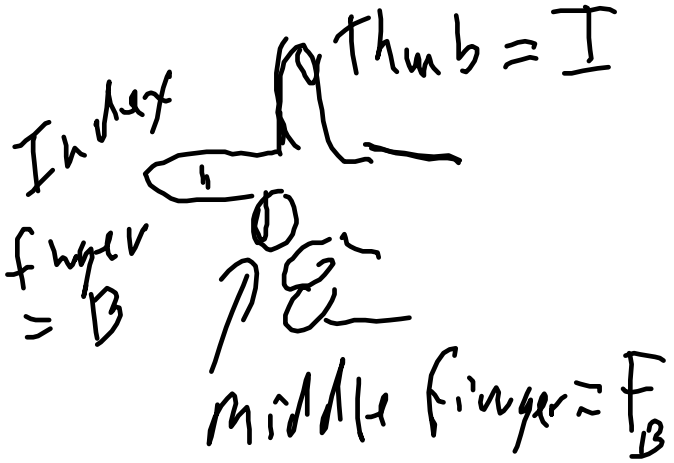
When a current, I, flows in a magnetic field, B, it experiences a magnetic force, F_B

$F_B = BIL$

where L is the length of wire perpendicular to the field, B.

(F_B=BILsinθ with θ as the angle between B and L)

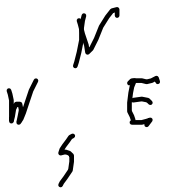
Third and last right hand rule:

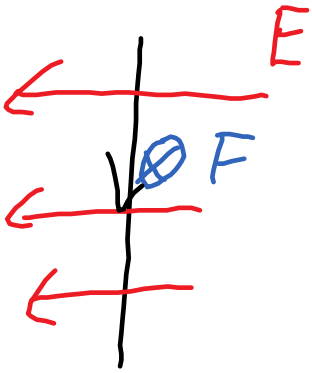


eg. A wire with 5.0 A of current flowing North to South has 2.0 cm in a magnetic field, B going East to West. The wire experiences 0.020N of force.

a) what is the direction of the force?

b) what is the magnitude of the magnetic field?





Force is into the page or towards the centre of the Earth

$$F = BIL =$$

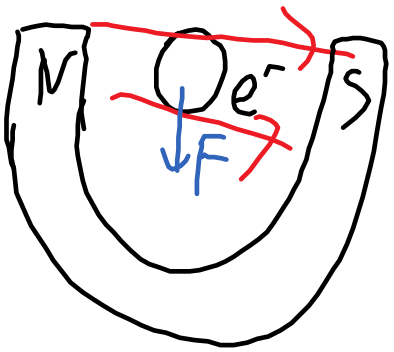
$$B = \frac{F}{IL} = \frac{0.02N}{5A(0.02m)}$$

$B = 0.20\ T$ $\left(T = \frac{N}{A(m)}\right)$ *

magnetic field is a vector - direction from North to South end of the magnet or using right hand rules.

Cathode Ray Tube

Beam of Electrons



Thumb is opp. to the flow of e^-

$F_B = qvB\sin\theta$

v is the velocity of the charged particles, in m/s
q is the charge of the particles

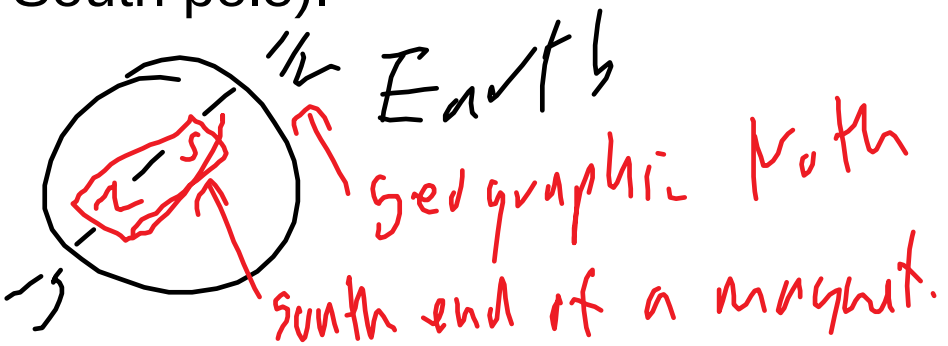
p533 Q1-13 odds

Block 2-3

Magnetism

What is magnetism? What do you know about magnets?

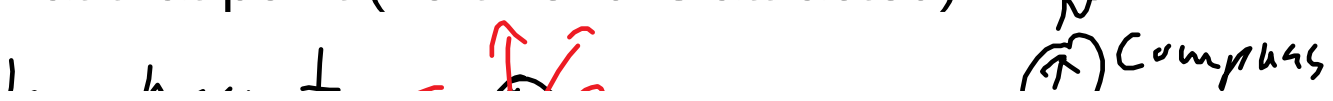
Magnets have North and South Poles, like poles repel, opposites attract.
The North end of the magnet it attracted to the Earth's geographic North pole (so it must be a magnetic South pole).



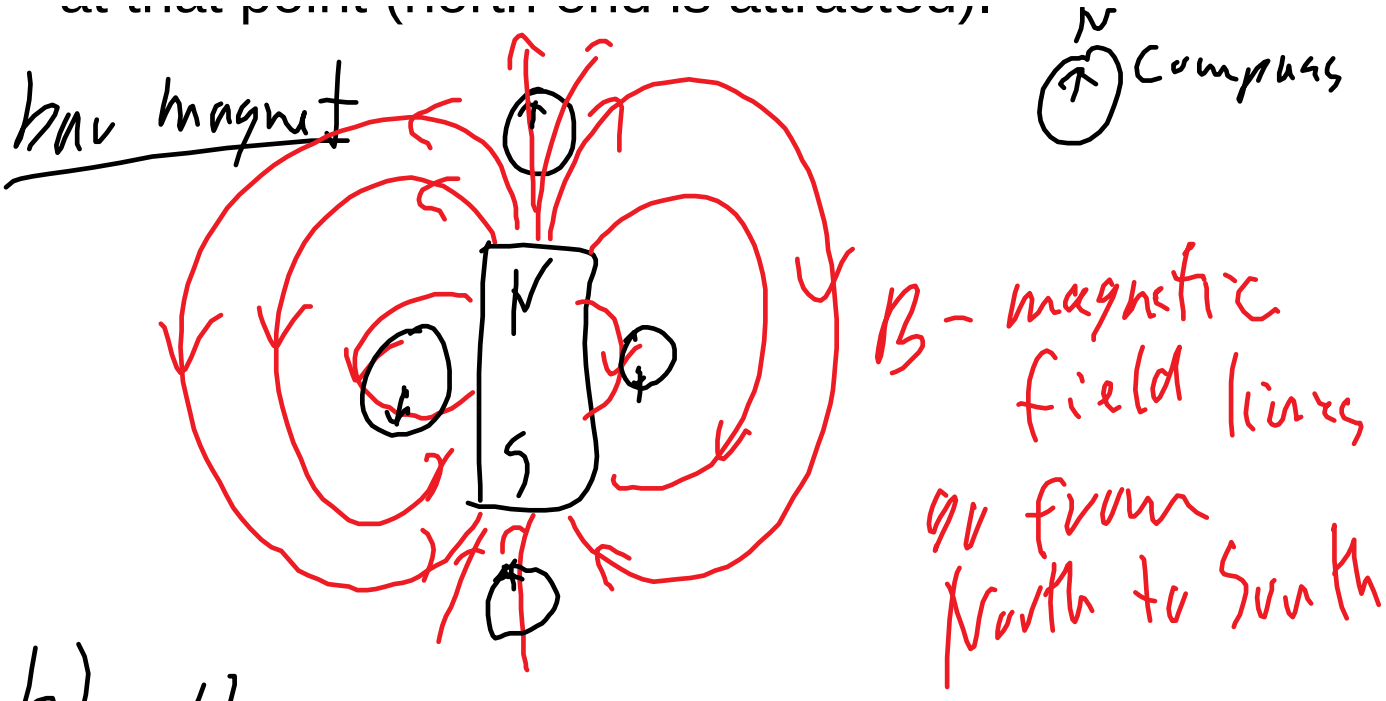
Magnets attract some metals (commonly iron but other metals are not attracted, like copper)

When we talked about charge we described the force acting between charges as a field, E (from positive to negative and show the direction of force on a positive charge)

Magnetism can be looked at as a magnetic field, B. Define the direction of the field as the direction a compass (a small magnet) will point at that point (north end is attracted).



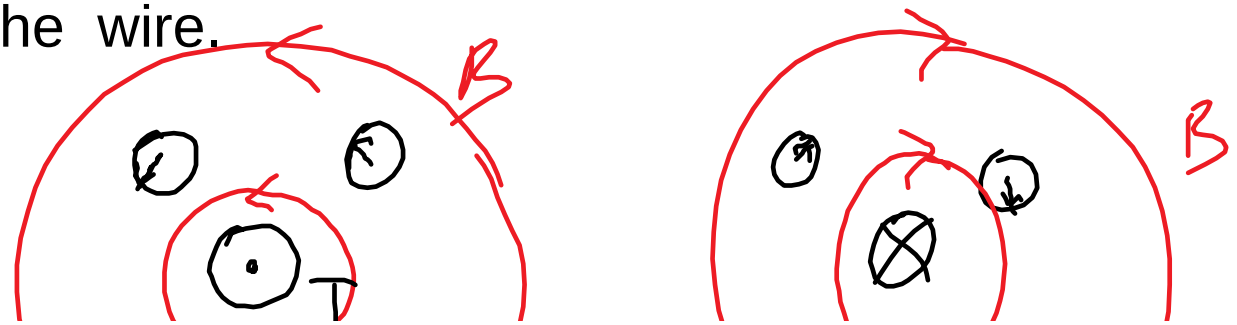
at that point (north end is attracted).

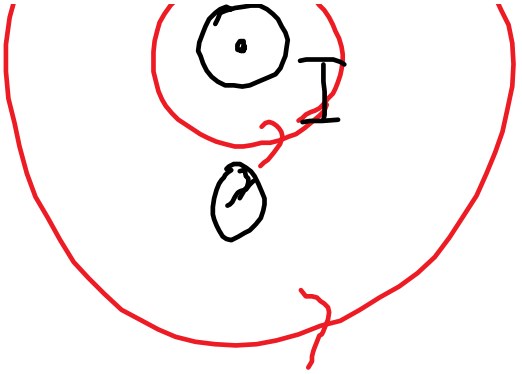


b) Horse shoe Magnet

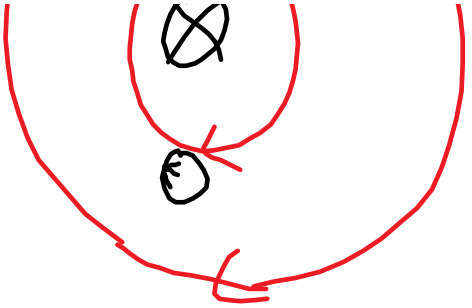
field is stronger in the middle (go N to S)

c) we have a wire with current, I, going into the page (an x in a circle, or just an x) and current going out of the page (an dot in a circle or just a dot).
We find there is a magnetic field produced around the wire.



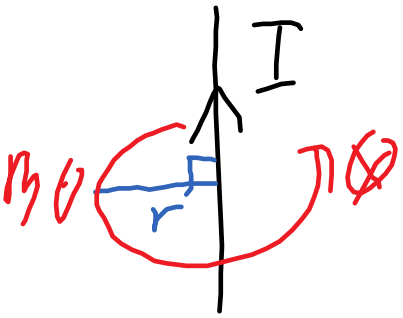


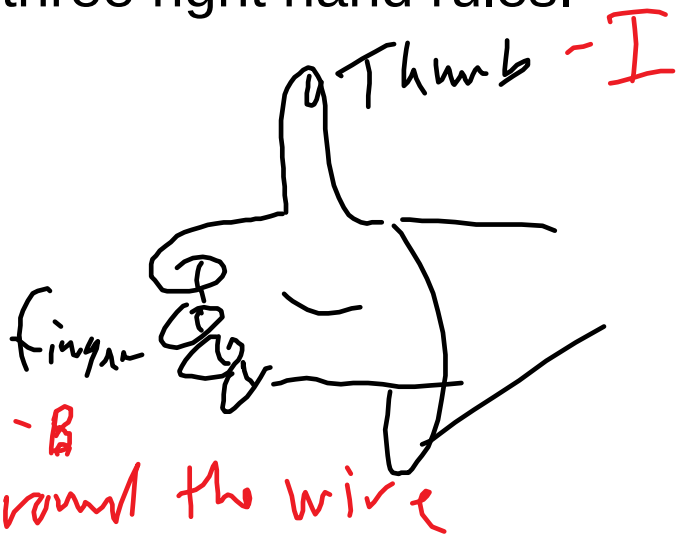
current out of page
counter-clockwise B



current into the page
clockwise B

You can predict the direction of the magnetic field using our first of three right hand rules.



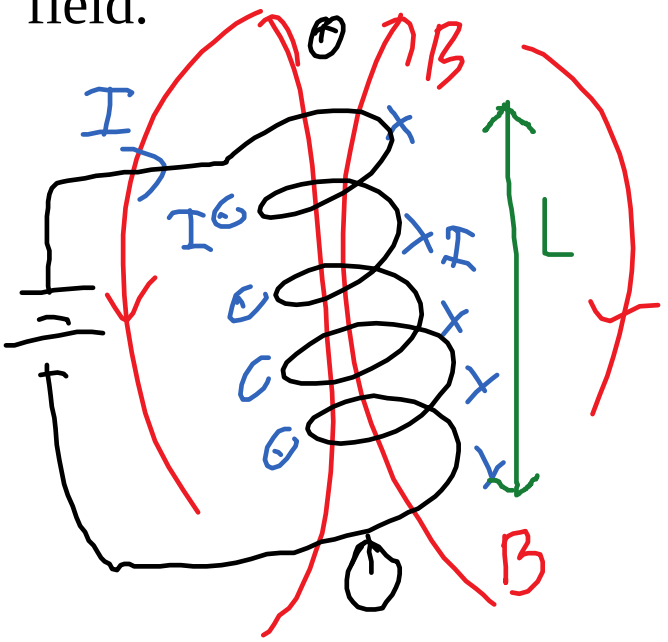


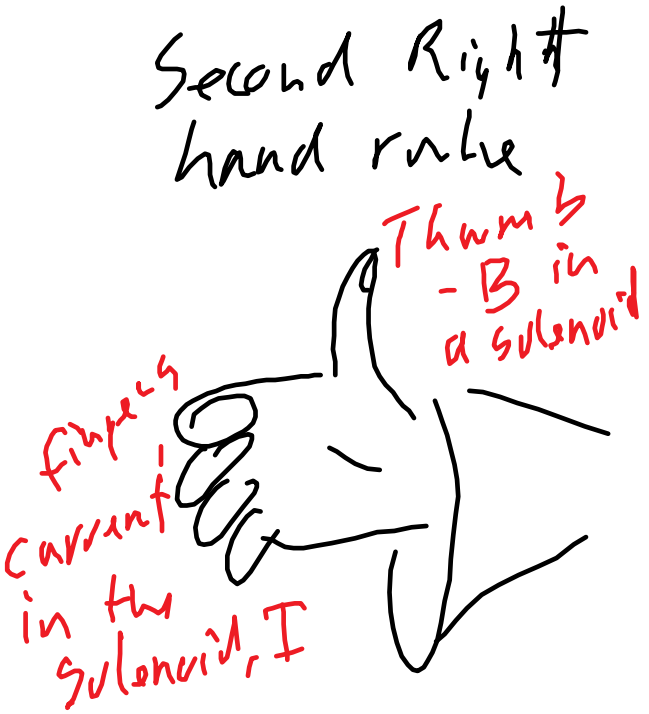
$B = \mu_o I/(2\pi r)$

B is the magnetic field strength in Teslas, T=N/Am
I is the current, in Ampères, A
r is the perpendicular distance to the wire, in m.
μ_o is the permeability of free space, a fundamental constant of nature.
$\mu_o = 4\pi \times 10^{-7}$ Tm/A

d) look at a solenoid, a coil of wire with N loops (N is the number of loops) produces a stronger magnetic

d) look at a solenoid, a coil of wire with N loops (N is the number of loops) produces a stronger magnetic field.





$$B = \mu_0 \frac{N}{L} I = \mu_0 n I$$

B is the magnetic field inside the solenoid, in T
I is the current in the wires, in A
N is the number of loops.
L is the length of the solenoid in m.
n is the number of loops per unit length, N/L.

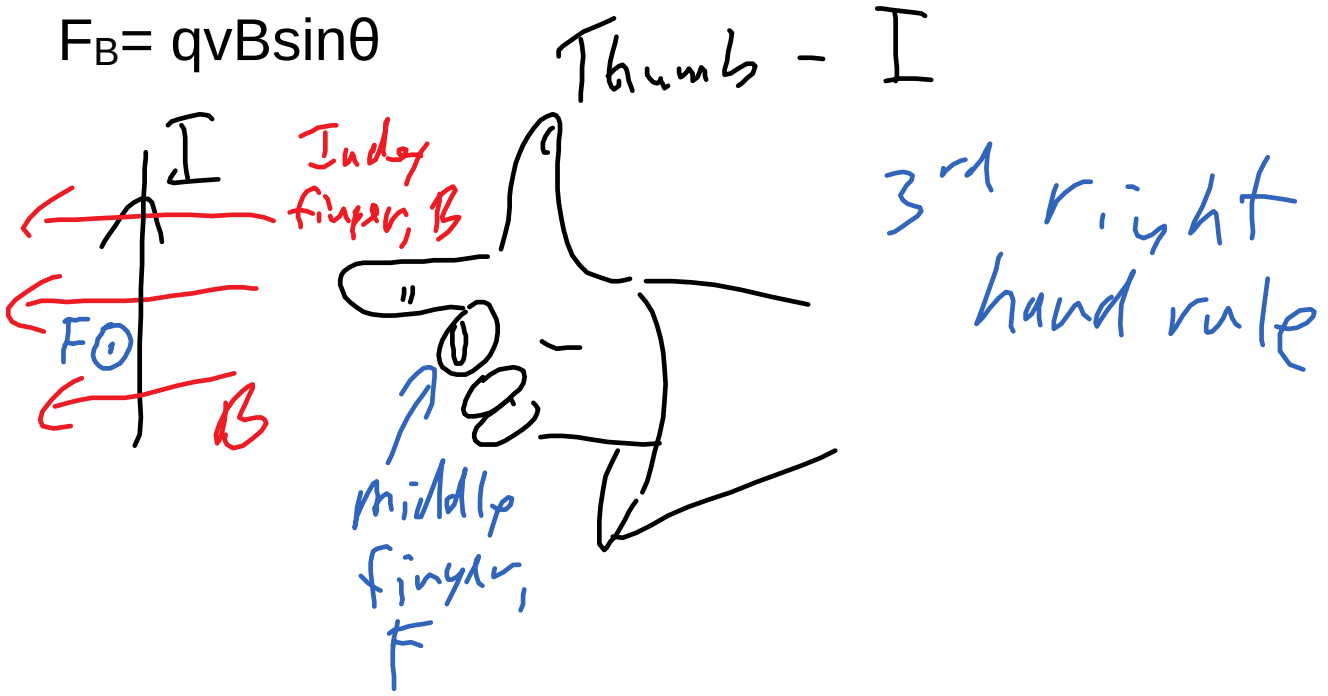
Magnetic Force, F_B

When a current, I, flows in wire with length, L, in a magnetic field, the wire experiences a magnetic force, F_B.

$F_B = BIL\sin\theta$ where θ is the angle between the wire and the magnetic field. Greatest when they are perpendicular.

same applies to a charge, q, moving at velocity, v, in a magnetic field.

$F_B = qvB\sin\theta$



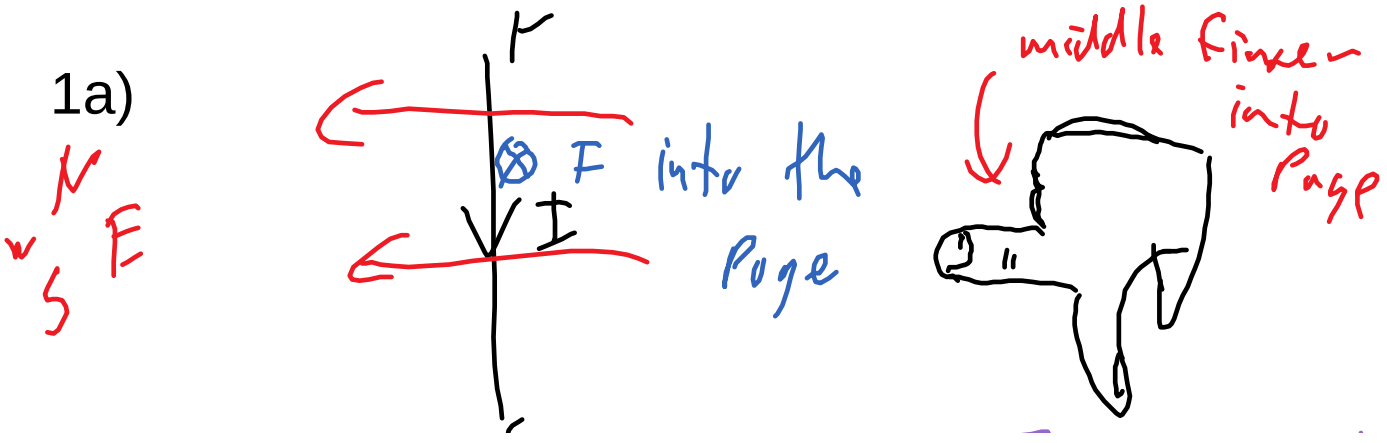
eg. 1. A wire flows with 5.0 A of current North to South with 2.0 cm in a magnetic field going East to West.

a) what is the direction of the force on the wire?

b) if the magnitude of the force is 0.020N, what is the magnetic field strength?

2. An electron is moving at 2.0 x 10^6m/s South to North and hits a 0.050 T magnetic field going up. What is the size and direction of the force on the electron? (q=1.602x10^{-19}C)

1a)

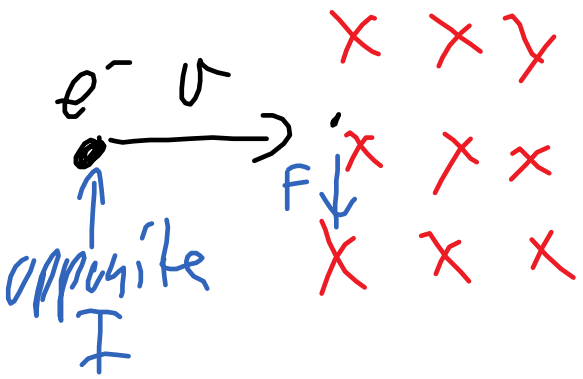


$F = BIL$ & $B = \frac{F}{IL} = \frac{0.02\,N}{5A(0.02m)}$

$0.02\,cm \rightarrow m$

$\boxed{B = 0.20\,T}$

2.



$F = qvB$

$= 1.6\times10^{-19}(2\times10^{6})(0.15)$

$= \boxed{1.6\times10^{-14}\,N}$

p533 Q1-13 odds